III. "Researches in Spectrum-Analysis in connexion with the Spectrum of the Sun.—No. V." By J. NORMAN LOCKYER, F.R.S. Received January 10, 1877.

(Abstract.)

The author submits to the Royal Society the first portion of a new map of the solar spectrum, w.l. 39–40 ten millionths, constructed after the manner described in a previous "Preliminary Note."

February 15, 1877.

Dr. J. DALTON HOOKER, C.B., President, in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The President read the following letter:—

To the President of the Royal Society, London.

We have the honour to inform you of the establishment of a Scientific Club, under the presidency of His Excellency Dr. A. Ritter von Schmerling, and to request you to do us the favour of communicating the fact to the Fellows of the Royal Society.

We beg to invite the Fellows of the Royal Society to make use of this Club during their occasional stay in Vienna, either as guests or as foreign members.

We have the honour to subscribe ourselves, on behalf of the Club,

Yours obediently,

The Vice-Presidents { HOFRATH VON HAUER, *Director of the Imperial Geological Institute.* HOFRATH BRUNNER VON WATTENWYL.

DÖBLHOFF, 1. *Secretary.*

Vienna, Feb. 1877.

Club and Office:

1. Eschenbach-Gasse, No. 9, 1st floor.

The following Papers were read:—

I. "On Stratified Discharges.—III. On a Rapid Contact-Breaker, and the Phenomena of the Flow." By WILLIAM SPOTTISWOODE, M.A., F.R.S. Received January 9, 1877.

In a paper published in the Proceedings of the Royal Society, vol. xxiii. p. 455, I have described a form of contact-breaker designed for great rapidity and steadiness of action. It consisted of a steel rod which vibrated under the action of an electromagnet. As regards sharpness of break and steadiness of definition in the striæ, this instrument left little or nothing to be desired. But, as explained in the paper above quoted, an alteration in the current not only affected the steadiness directly, but also reacted on the break itself. The effects due to an alteration of the current alone thereby became masked, and the study of the laws relating to such changes was rendered more difficult, or altogether impracticable. In order to obviate this inconvenience I devised another form of contact-breaker, in which the vibrating rod and electromagnet were replaced by an arrangement purely mechanical in its action, and therefore entirely under control.

This instrument consists essentially of a wheel platinized at the edge, on which a platinum spring rests. In the circumference of the wheel a number (40 in the first instance) of slots were cut, and filled with ebonite plugs so as to interrupt the current. The breadth of the slots was about ·04 inch, and that of the teeth about ·5 inch. The wheel was connected with suitable driving gear, so as to give from 250 to 2000 currents from the coil in each direction per second. A 4-inch coil was found sufficient to produce the effects; but the 18-inch coil by Apps, mentioned in former communications, was preferable. With the wheel, as with the electromagnetic break, a very slight strength of current was required; but, on the other hand, high tension in the primary was found necessary. In many of the experiments accordingly from 10 to 20 of the smallest Leclanché cells usually made were employed with the small, and from 20 to 50 with the large coil. But these were afterwards replaced by a double fluid battery suggested by my assistant, Mr. P. Ward, and described at the end of this communication.

For some time the experiments were conducted with the platinum spring resting on the wheel; and the effects were varied by altering either the pressure of the spring or the velocity of the wheel; but the gradual abrasion of the platinum through friction proved to be a fruitful source of irregular results. This irregularity of action, at all times difficult to compensate, and sometimes insuperable, was fortunately removed by a simple although delicate adjustment. It was, in fact, found that actual metallic contact between the spring and wheel was not necessary, provided that a layer or cushion of conducting material were interposed. Such a layer was formed by a thin film of liquid drawn out by a thread leading from a reservoir and resting on the wheel. Various fluids were

tried; but the simplest, and on the whole the best, proved to be dilute sulphuric acid, in the proportion of 1 drop of acid to 6 drams of water. Generally speaking the better conductor the fluid is, the better are the results obtained; but, owing to the insulating slots being very narrow in this instance, a comparatively weak mixture of acid and water was necessary. In one wheel, where the insulating slots are $\frac{1}{4}$ in. wide, a mixture 36 times as strong may as advantageously be used. The spring, which under these circumstances became unnecessary, was replaced by a point, the adjustment of whose distance from the wheel was simpler and more accurate. This arrangement gave excellent results, even when the number of currents per second was reduced in some cases to 250; added to which the unpleasant and disturbing noise of the friction was entirely avoided.

Wheels having different numbers of teeth were also constructed, and (what was perhaps of more importance) having teeth of different breadths, so as to give with the same velocity of rotation contacts of different duration. The breadth of the ebonite plugs, or length of interruption of the current, was immaterial, so long as the current was efficiently broken. It did not appear, however, that with the same tube more could be obtained with wheels having different numbers of teeth, than with the same wheel at different speeds. But it was found that for different tubes different wheels occasionally gave better results.

With the contact-breaker here described effects similar to those produced by the rapidly vibrating break were obtained. The striæ were formed in a regular manner, and advanced or receded, or remained at rest, in a column usually unbroken, so long as the velocity of the wheel was maintained without change; and even in the longer tubes, where the striæ, of the double discharge, advanced or receded towards both ends at the same time, and appeared sometimes compressed and at others dilated, the phenomena always maintained their characteristic features.

The condition of the striæ here described, whether flowing or stationary, may be comprised under the general term "steady;" and when there is no motion in either direction, they may be specifically denominated as "stationary."

Two questions here presented themselves:—First, what are the conditions necessary for the production of steady striæ? Secondly, what are the conditions and circumstances of the advance and retreat, in other words, of the flow of steady striæ?

With a view of ascertaining the nature of the distinction between the ordinary and the steady striæ, careful observations were made with the revolving mirror. It having been noticed that when the wheel break moved slowly ordinary or irregular striæ were produced, and that when it moved rapidly steady striæ resulted, it seemed probable that the latter effect might be due to the short time of contact, and to the consequent absence of many of the features described in Part II. of these researches.

This is, in fact, identical with the suggestion there made, that the fluttering appearance was due to the unequal duration of the striæ themselves, and to the irregular positions of the points at which they were renewed at successive discharges of the coil. And such, in fact, proved to be the case; for as the speed of the wheel was increased the duration of the discharges diminished; the image as seen in the mirror became narrower and simpler in its configuration, until, when the steady effect was produced, each discharge showed only a single column of striæ of a width proportional to the apparent width of the slit. The proper motion, implied by the inclination of the individual striæ to the vertical, was still perceptible, and was directed, as usual, towards the negative pole.

From a comparison of the number of striæ as seen by the eye with those seen in the revolving mirror, it was found that the striæ so formed were of the kind called "simple" in former communications. And the phenomena of the flow may therefore be considered to be due to the different positions taken up by the striæ in successive discharges. If in each discharge the striæ occupy positions in advance of those occupied in a previous discharge, the column will appear to advance; if the reverse be the case, they will appear to recede. If the positions remain unchanged, the column will appear stationary.

The following consequence of this explanation of the flow will readily occur to the reader, viz. that the rapidity of the flow will increase with the extent of advance made by the striæ in each successive discharge, until that advance amounts to half the distance between two contiguous striæ. Before this is attained the flow will have become too rapid to be followed by the unassisted eye, and can only be observed by the aid of the mirror. When this rate of advance has been exceeded, the flow will appear to be reversed. If the rate of advance still continues to increase, the rapidity in the reverse direction will appear to decrease until the advance amounts to the entire distance between two contiguous striæ, when it will apparently be reduced to zero; the striæ will then again appear stationary. Experiments appear to confirm this view of the case.

Experiments were next instituted with a view of ascertaining the connexion between the flow and resistance. Starting from a condition of current and break for which the striæ were stationary, it was found that an increase of resistance, introduced generally in the primary circuit, produced a forward flow, *i. e.* from the positive towards the negative terminal, while under similar circumstances a decrease of resistance produced a backward flow. Furthermore, if after producing a forward flow the resistance be continually increased, the flow after increasing in rapidity so as to become indistinguishable by the unassisted eye, gradually appears to become slower, and ultimately to reverse itself, in accordance with the law suggested above.

Another form of contact-breaker was also occasionally used. The principle upon which it was based was the sudden disruption of a thin

film of conducting liquid by a discharge between the electrodes of a circuit. The mode of effecting this was to make one electrode terminate in a platinum plate fixed in a horizontal position, and supplied with a uniform film of dilute sulphuric acid; the other in a platinum point, the distance of which from the plate is capable of delicate adjustment by means of a screw. Electromotive force required for this break is not less than that of 5 cells of Grove.

As soon as the current passes, the fluid between the plate and point will be decomposed and electrical continuity broken. This done, the fluid flows back again, and continuity is restored. By a proper adjustment of the supply of fluid and of the distance of the electrodes (the latter varying from ·05 inch to ·001 inch), the number of disruptions may be made to attain 1000 per second.

The currents delivered by this form of break are exceedingly uniform, and the effects produced are quite equal in delicacy to those produced by the electromagnetic or by the wheel break.

The elements used in the battery to which allusion was made in the early part of this paper are zinc and carbon. The zinc is immersed in dilute sulphuric acid in the proportions of 1 volume of acid to 7 of water; and the carbon in a saturated solution of bichromate of potash with 1 volume of sulphuric acid to 7 of the solution. The carbon and bichromate solution are held in a porous cell.

The absence of nitric acid permits this battery to be used in a room; while the fact that the zinc is attacked only when the circuit is complete, renders it unnecessary to lift the plates out of the fluid when not in use, as in the bichromate battery. The only limit to the time during which this battery may be left untouched, appears to be the period when the bichromate salt finds its way into the outer cell, so as to attack the zinc independently of electrical action. But this does not take place to an extent materially to affect the action for some months.

II. "Lymphatics and their Origin in Muscular Tissues." By George Hoggan, M.B., and Frances Elizabeth Hoggan, M.D. Communicated by Dr. Billing, F.R.S. Received January 18, 1877.

The authors announce that they have discovered the long-looked-for lymphatics of striated muscle, and describe them as radicles, valveless reservoirs, and valved efferent vessels. While describing their structure and relations, they point out that the reservoirs are found on one plane or side of a muscle; the valved efferents are found on the other side, as, for example, in the case of the diaphragm, transversalis abdominis, and triangularis sterni muscles. In connexion with this, they have discovered